Chapter 2
Relief Well Applications

2-1. Description

Pressure relief wells as used in this manual refer to vertically installed wells consisting of a well screen surrounded by a filter material designed to prevent inwash of foundation materials into the well. A typical relief well is shown in Figure 2-1. The wells, including screen and riser pipe, have inside diameters generally between 6 and 18 inches (in.), sized to accommodate the maximum design flow without excessive head loss. Well screens generally consist of wire-wrapped steel or plastic pipe, slotted or perforated steel or plastic pipe. Slotted wood stave well screens, which are no longer manufactured, are found in many existing installations. Details of various well screens are given in Chapter 6.

2-2. Use of Wells

a. Relief wells are used extensively to relieve excess hydrostatic pressures in pervious foundation strata overlain by more impervious top strata, conditions which often exist landward of levees and downstream of dams and various hydraulic structures. Placing the well outlets in below-surface trenches or collector pipes serves to dry up seepage areas downstream of levees and dams. Relief wells are often used in combination with other underseepage control measures, such as upstream blankets, downstream seepage berms, and grouting. Horizontal stratification of pervious foundation deposits is not a major deterrent to the use of relief wells, as each of the more pervious foundation strata can be penetrated. The use of relief wells for levee systems is discussed in EM 1110-2-1913; their use for earth and rock-fill dams is discussed in EM 1110-2-2300.

b. Relief wells provide a flexible control measure as the systems can be easily expanded if the initial system is not adequate. Also, the discharge of existing wells can be increased by pumping if the need arises. A relief well system requires a minimum of additional real estate as compared with other seepage control measures such as berms. However, wells require periodic maintenance and frequently suffer loss in efficiency with time for a variety of reasons such as clogging of well screens by intrusions of muddy surface waters, bacterial growth, or carbonate incrustation. Relief wells may increase the amount of underseepage which must be handled at the ground surface, and means for collecting and disposing of their discharge must be provided (Turnbull and Mansur 1954). Adequate systems of piezometers and flow measuring devices must be installed in accordance with ER-1110-2-110 and EM 1110-2-1908 to provide continuing information on the performance of relief well systems.

2-3. History of Use

a. The first use of relief wells to prevent excessive uplift pressures at a dam was by the US Army Engineer District, Omaha, when 21 wells were installed from July 1942 to September 1943 as remedial seepage control at Fort Peck Dam, Montana (Middlebrooks 1948). The foundation consisted of an impervious stratum of clay overlaying pervious sand and gravel. Although steel sheet piles were driven to provide a complete cutoff, leakage occurred and high hydrostatic pressure developed at the downstream toe with an excess head of 45 feet (ft) above ground surface. The high pressure was first observed in piezometers installed in the pervious foundation. The first surface evidence of the high hydrostatic pressure came in the form of discharge from an old well casing that had been left in place. Since it was important that the installation be made as quickly as possible, 4- and 6-in. well casings, available at the site, were slotted with a cutting torch and installed on 250-ft centers in the pervious stratum with solid (riser) pipes extending to the surface. The excess head at the downstream toe was reduced from 45 to 5 ft, and the total flow from all wells averaged about 4500 gallons per minute (gpm). However, the steel screens corroded severely and in 1946 were replaced by 17 permanent wells consisting of 8-in.-ID slotted redwood pipe at a spacing of 125 ft.

b. The first use of relief wells in the original design of a dam was by the US Army Engineer District, Vicksburg, when wells were installed during construction of Arkabutla Dam, Mississippi, completed in June 1943. The foundation consisted of approximately 30 ft of relatively impervious loess underlain by a pervious stratum of sand and gravel. The relief wells were installed to provide an added measure of safety with respect to uplift and piping along the downstream toe of the embankment. The relief wells consisted of 2-in. brass wellpoint screens 15 ft long attached to 2-in. galvanized wrought iron riser pipes spaced at 25-ft intervals located along a line 100 ft upstream of the downstream toe of the dam. The tops of the well screens were installed about 10 ft below the bottom of the impervious top stratum. The well efficiency decreased over a 12-year period by about 25 percent primarily

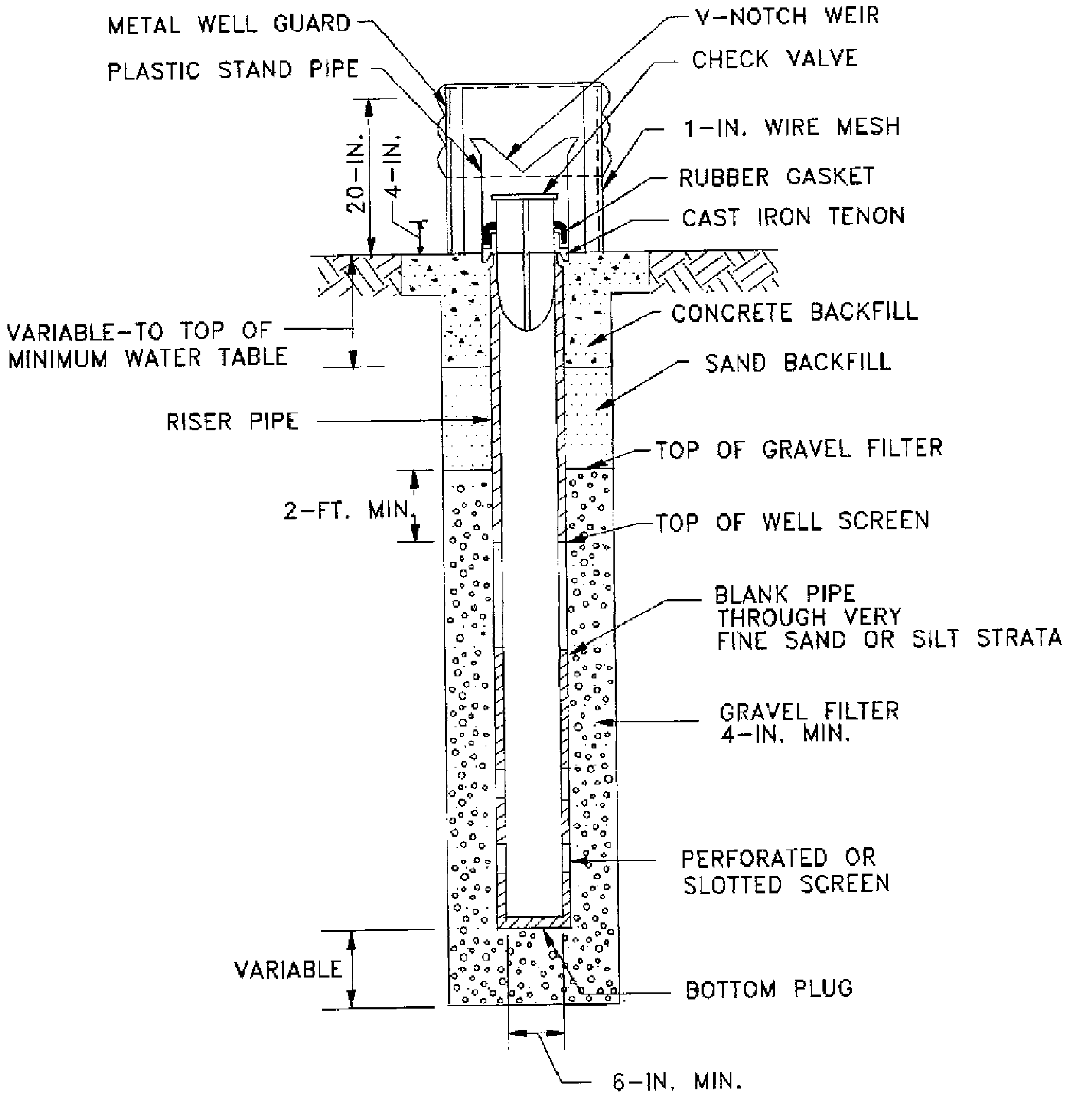

Figure 2-1. Typical relief well (after EM 1110-2-1913)

as a result of clogging of the screens. However, the piezometric head along the downstream toe of the dam, including observations made at a time when the spillway was in operation, has not been more than 1 ft above the excess head of 9 ft was observed (US Army Engineer Waterways Experiment Station 1958). Since these early installations, relief wells have been used at many levee locations to control excessive uplift pressures and piping through the foundation.

2-4. Other Applications

Pressure relief wells have also been used extensively beneath the stilling basins of spillways, outlet structures, and other hydraulic structures. In addition, wells have been employed to control excess hydrostatic pressures in outlet channels including areas immediately downstream of navigation locks. Often wells incorporated in structures have been located so that they discharge through collector pipes and manholes which are not readily accessible to cleaning and maintenance unless the structures are dewatered. An example of a relief well system incorporated into a toe drainage system for a dam is shown in Figure 2-2.

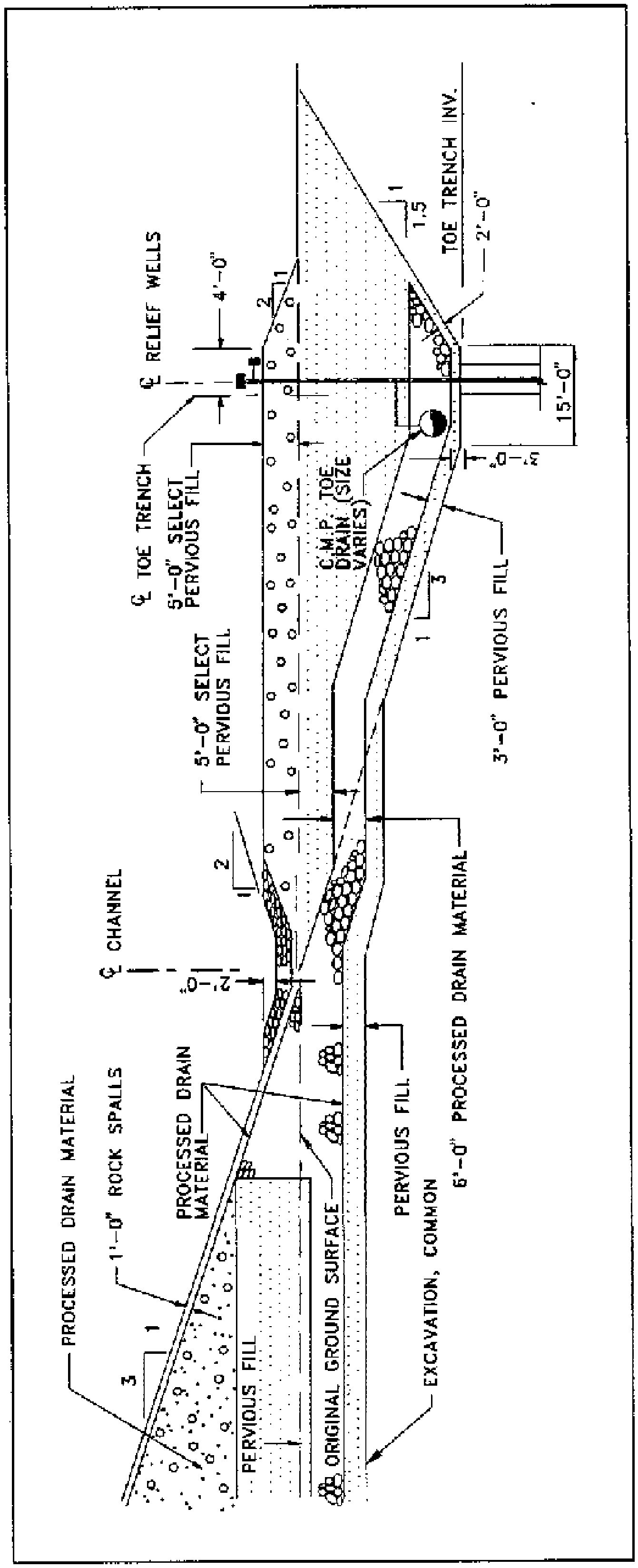

Figure 2-2. The drainage system with relief wells at Cochiti Dam